is because the true conduction current is so much greater proportionally in water than in glass. In certain experiments, which we hope to have the honour of describing fully in a future paper, we have been able to make an approximation to the time integral of this *conduction current* during the small times of first charge and discharge, and by subtracting it from the measured charge, or adding it to the measured discharge, we have obtained what we may reasonably call the true induction charge in a voltameter. We mention this now since, although years ago Mr. Cromwell Varley referred to the electrostatic capacity of voltameters, the investigation of this instantaneous charge has been neglected, because this charge is small compared with the residual one, just as the important investigation of the residual charge in Leyden jars was for a long time not carried out, because the residual charge was small compared with the instantaneous charge.

For assistance rendered in the carrying out of the series of experiments, the results of a few only of which are given in this preliminary account, we have to thank the following of our students:—Messrs. Fujioka, Igarashi, Iida, Inoguchi, Kasai, Kawaguchi, Mita, Nobechi, Oshima.

III. "On the Structure and Development of the Skull in the Batrachia. Part III." By W. K. PARKER, F.R.S. Received April 29, 1880.

(Abstract.)

Some of the work brought forward in this paper was in hand before the first part was in print. That initial piece of work dealt only with the formation of the skull in the common frog, but it was followed by another which appeared in the "Philosophical Transactions" in 1876, which treated of the skulls of the *common* and of the "aglossal" toads.

Of the latter types only two kinds are known, viz., the nailed toad of the Cape (*Dactylethra*), and the monstrous toad of Surinam (*Pipa*). All the bulk of the Batrachia are included in the sub-group "Opisthoglossa," these have a tongue, and in most cases it is free *behind* and not in front; the "Proteroglossal" Batrachia are very few in number, and the character itself (as Dr. Günther informs me) is not well pronounced.

I have now worked out the skull, in one or more stages, in about a *tithe* of the known species, and in my second paper in both of the aberrant ("aglossal") types; in them this was done in various stages.

I am not aware that there is any "order" of any "class" in the Vertebrata where so large a percentage of species has been, or indeed,

need be, worked out, either in the skull or in any other part of their organisation.

That which calls for it here is the great and unlooked-for polymorphism of the species; I may explain this by saying that the skull, in really important modifications, differs more in the species of some of the genera than it does in the orders of some of the classes. As an instance, it would be no easy thing to find a malacopterous fish differing from an acanthopterous type, in deep-seated essential matters, so much as the common toad does from the other native species, viz., the *Natterjack;* and the common frog has only about half as many cranial elements as the bull-frog of North America.

If the metamorphosis of a single species be worked out exhaustively, it gives a range of structural characters which rises up from a larval creature on the level of the lamprey, to a reptilian form, not far below the Chelonia, and evidently related (obliquely, not genetically) to that "order."

Moreover, whilst the "opisthoglossa" have larvæ with suctorial mouths, and a *quasi-petromyzine* structure altogether, the larvæ of the "aglossa" need only to be arrested as larvæ, and to acquire a dense bony armature to be very close counterparts of the most *bizarre* forms of the ganoids of the "old red sandstone," such as *Pterichthys* and *Coccosteus*.

The Batrachia show some remarkable things in their metamorphosis, both as to the *size* their larvæ obtain, and the *time* during which metamorphosis is taking place.

In the bull-frog (*Rana pipiens*) the larvæ attain the length of about 5 inches, and take two or three years for their transformation; they may be hindered in this, and be made to take twice that time. In these the larvæ bear a moderate relation, as to size, to the adult form, which may be 7 inches long, although tail-less.

But in a frog from the neotropical region (*Pseudis*) scarcely larger than our native form, the tadpole attains the length of nearly a foot, the tail acquiring a breadth of 4 inches.

As zoologists well know, it is easy to procure *tadpoles* of this species, but very hard to get an adult. I am of opinion that the adult condition is not attained until after many years; and it suggests itself to me that this species may be the not remote descendant of a type which did not finish its *anural* metamorphosis.

On the other hand, some of the neotropical forms have very small tadpoles. *Bufo chilensis*, a large toad, has them about half the size of those of our common native Batrachia, and the newly-metamorphosed individuals are no larger than a house-fly.

But in *Pipa* the small larvæ are thoroughly metamorphosed in the maternal dorsal pouches, and at first only do they show a trace (and only a trace) of branchial tufts.

These tadpoles, which never see the light as such, have wide mouths (not suctorial), and so also have the tadpoles of the other waif of the sub-order "Aglossa," viz., *Dactylethra*. In that kind, however, the larvæ become large, and are a long while undergoing their transformations, which take place in the water, according to rule.

In the skull of the adults much variation is evidently due to the different size to which the species attains; some, as the bull-frog, are as large as the common Greek tortoise, others grow scarcely larger than a bluebottle fly. As a rule, these small kinds show two kinds of modification—they are apt to retain certain larval characters, and they are apt to acquire generalized characters, such as do not normally appear in this group, which is very remarkable for the fewness of the parts or elements composing the adult skull.

Some of the large forms, as *Rana pipiens*, have many investing bones in their skull, such as must be looked for again in archaic and extinct types, whilst others, as *Ceratophrys* and *Calyptocephalus*, have a cranial armature that is dense, extended, and almost "ganoid;" this kind of skull, however, is found in middle-sized types also, as in *Pelobates* and *Nototrema*.

In the terminal suctorial mouth of the larva of the Opisthoglossa, the mandibular pier, and its free "ramus" are carried to the front of the head. After transformation, in the larger kinds, the gape is carried behind the head, as in the crocodile; it can be guessed how much modification such a change as this will necessitate.

But it is evident that a low suctorial fish, such as the *tadpole* is, must have altogether a totally different kind of skull and skeleton to that of an active, noisy, intelligent, more or less terrestrial reptile, such as the frog becomes.

This necessarily great change involves some very curious and instructive anachronisms, so to speak, in the appearance of various parts and organs.

A low suctorial fish would have no fenestra ovalis nor stapes, and in the tadpole it is some time before these appear.

The low (urodelous) Amphibia have, in most cases, the upper hyoid element suppressed, sometimes it is present, serving as a rudimentary "*columella auris*."

In most Batrachia this part does not appear until after transformation, and in some kinds not at all. This part especially shows how the individual is gradually changed, and makes it clear why so many variations should occur in genera and even species.

I have arranged the forms, whose skulls are worked out zoologically, taking in the results of my earlier observations, already published in the "Philosophical Transactions."

These now amount to *seventy-five;* four of these have already been treated of, and of the new types four kinds are only larval; neverthe-

less, I am able, after many years of labour, to give an account of the adult skull in seventy kinds, and of the larval—in one or several stages—in a good number of the species.

The illustrations are, for the most part, put in a similar manner in all the plates; and, as to *size*, I have not made the skulls of the dwarf kinds much less than those of the large types.

I am satisfied that these figures and descriptions will be found useful, not merely for comparison of the types of larval and adult Batrachian skulls one with another, but I believe that they will throw light upon, and in turn be illuminated by, all that we can learn of the structure and development of the skull in the other types of Vertebrata.

With regard to the geographical distribution of the Batrachia, there are many things of importance which I have rather hinted at than expressed in this paper.

There is a sort of *facies* or character about the allied types of any great geographical region which makes me satisfied that certain external characters repeat themselves again and again in different parts of the world.

Thus, the types of frogs that have dilated toes are evidently more nearly related to those with pointed toes of the same region than they are even to the broad-toed types of some distant region.

I should be inclined to derive the narrow-backed tree frogs of Australia from the sharp-toed frogs of the same region; the same with those of India, and the same with those of the nearctic and neotropical territories.

The true frogs ("Ranidæ") of India have many things in common, as also have the true frogs of North America; the same may be said of the sub-typical frogs, or "Cystignathidæ."

On the whole, the European and Indian territories yield the highest kinds; Australia and South America the lowest and most generalized.

IV. "On the Relation of the Urea to the Total Nitrogen of the Urine in Disease. No. I." By W. J. Russell, Ph.D., F.R.S., and Samuel West, M.B. Oxon. Received May 6, 1880.

In the valuable series of papers upon the excretion of urea, communicated by Professor Parkes to the Royal Society, he showed that in health 90 per cent. of the nitrogen in the urine, was eliminated in the form of urea. It seemed to us of considerable interest and importance to ascertain whether in disease this statement still held good, or whether, as indeed seemed probable, under altered conditions,